IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
BOARD OF PATENT APPEALS AND INTERFERENCES

In re patent application of:	) Date: April 18, 2008
Robert A. Cordery et. al.	) Attorney Docket No.: F-714
Serial No.: 10/720,292	) Customer No.: 00919
Filed: November 24, 2003	) Group Art Unit: 2625
Confirmation No.: 4123	) Examiner: Jacky X. Zheng

Title: DETECTING PRINTED IMAGE COPIES USING PHASE-SPACE-ENCODED FRAGILE WATERMARK

APPELLANT'S BRIEF ON APPEAL

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

This brief is in furtherance of the Notice of Appeal filed in this case on February 19, 2008.

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I. Real Party in Interest

Pitney Bowes Inc. is the real party in interest by way of assignment from the Appellant.

II. Related Appeals and Interferences

There are no related Appeals and Interferences.

III. Status of Claims

(1) Claims 1, 2, 4-12 and 14-19 are in the application.

(2) Claims 3, 13 and 20-25 have been cancelled.

(3) Claims 1, 2, 4-12 and 14-19 are rejected.

(4) Claims 1, 2, 4-12 and 14-19 are on appeal.

IV. Status of Amendments

No Amendment subsequent to the November 21, 2007, Final Rejection was entered.

V. Summary of Claimed Subject Matter

This invention relates to the field of printed document security, and to the detection of a watermark in a printed image to determine whether the printed image is an original or a copy. Secure documents are created with printed images that incorporate special features, sometimes referred to as "fragile watermarks", wherein copying of the printed image results in changes of the feature in the copy relative to the original image in a manner that can be detected with a degree of reliability and convenience.

Claim 1 is one of the two independent claims in this application. Claim 1 relates to a method for determining whether a printed-image-under-examination (PIUE) is a copy of an original printed image. The method comprising the following steps:

(a) scanning the PIUE (Fig. 6 600, Paragraph 0053, Page 18) to generate scanned image data, the scanned image data comprising pixel data, the pixel data comprising gray scale values and representing the PIUE as a set of scanning pixels;

(b) forming a plurality of data blocks (Fig. 6 602, Paragraph 0054, Page 18) from the scanned image data, each data block consisting of pixel data which corresponds to a

respective region of the PIUE;

(c) transforming the pixel data (Fig. 6 606, Paragraph 0056, Page 18) in at least some of the data blocks to obtain transform domain data by applying at least one of a Fourier transform, a fast Fourier transform, a discrete cosine transform (OCT) and a wavelet transform to the pixel data in the at least some of the data blocks to obtain the transform domain data;

(d) applying a watermark detecting operation (Fig. 6 608, Paragraph 0056, Page 18) to the transform domain data for respective ones of the data blocks to generate recovered watermark data; and

(e) determining a correlation (Fig. 6612, Paragraph 0058 Page 19) between the recovered watermark data for at least some of the data blocks and average brightness levels for said data blocks.

Appellant's invention is shown in paragraph 052 of page 6 to paragraph 060 of page 20 of Appellant's specification. Claim 1 is also illustrated in Fig. 6.

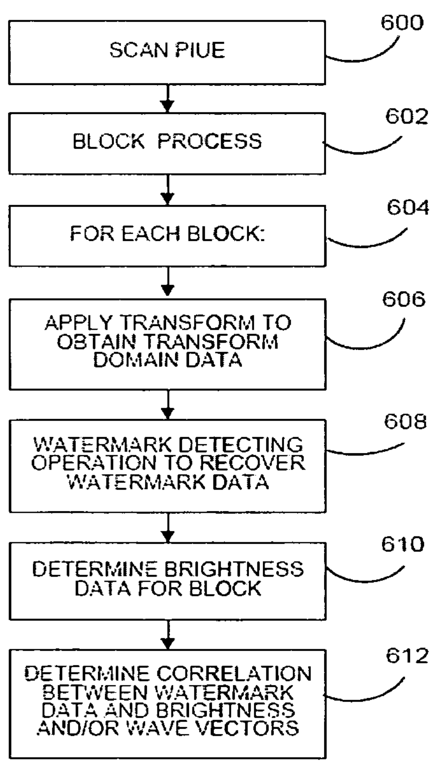


FIG. 6

[0052] FIG. 6 is a flow chart that illustrates a process that may be performed in accordance with the invention by the image examination apparatus 500 of FIG. 5 to

examine a PIUE to determine whether the PIUE is an original or a copy. In somewhat summary form, a process in accordance with the invention for detecting whether the PIUE is an original or a copy may include scanning the PIUE, detecting the watermark wave packets in the scanned PIUE, measuring the strength of the wave packets versus the background intensity and versus the wavelength of the watermark and applying a classification algorithum to determine whether the watermark is an original or a copy.

[0053] According to a first step 600 in the process of FIG. 6, the apparatus 500 scans the PIUE via the scanner 502 to generate scanned image data. The scanned image data is made up of pixel data that is constituted by gray scale values and represents the PIUE as a set of scanning pixels.

[0054} Following step 600 is step 602, at which the scanned image data is divided into data blocks. The data blocks may correspond to the real-space sub lattice of the phase space lattice that was used to encode the watermark in the image data that was provided for printing by the postage meter. In some embodiments, the data blocks may be overlapping.

[0055] Next, as indicated at 604, each of steps 606, 608 and 610 may be performed with respect to each of the data blocks formed at step 602.

[0056] Thus, for a particular block, step 606 indicates that a transform is applied to the pixel data of the data block to obtain transform domain data therefrom. In some embodiments the transform is a fast Fourier transform. Other transforms may alternatively be used, such as a Fourier trànsform, a discrete cosine transform (OCT) or a wavelet transform. Next, at step 608, a watermark detecting operation is applied to the transform domain data obtained at step 606. The detection of the watermark includes convolving the scanned image with a detection function. The detection function has the form EnvO(x, y) exp[i (kxx + kyY)]. Here EnvO is a similar function to EnvO. The absolute value of the correlation function shows peaks when the detection function is centered on the watermark wavepacket. The heights of these peaks provide a measure of the strength of each part of the watermark.

[0057] At step 610 (which may precede or follow steps 606, 608) the brightness of the data block in question may be determined. This may be done, for example, by calculating an average gray scale value of the pixels in the data block.

[0058] After the processing of steps 606, 608, 610 is completed, step 612 is performed. At step 612 it is determined whether there is a correlation between the strength of the watermark and the brightness of the various data blocks, and/or whether there is a correlation between the strength of the watermark data and the wave vectors that were used to encode the watermark in the data used to print the original image. In general, to the extent that the strength of the watermark is negatively correlated with the brightness of the scanned image data blocks, and/or is positively correlated with the wavelength of the wave vectors used to encode the watermark, the likelier it is that the PIUE is a copy rather than an original printed image. This is because the scanning and printing process that may be used to generate a copy tends to destroy watermark features where the image is brighter and to the extent that the watermark features are encoded with shorter wavelengths

[0059] (As used herein and in the appended claims, "wave vector" refers to a set of parameters that define a wave length and an orientation in two-dimensional space of a waveform.)

[0060] A classifying algorithm may be employed to determine whether the recovered watermark data from the scanned image data is indicative of an original printed image or a copy. In some embodiments, the classifying algorithm may be a linear classifier. The classifier may have been trained with a large number of known original images and known copies of original images. Other types of classifiers may be used, such as a Bayes classifier, linear regression, linear discriminant analysis, quadratic discriminant analysis, logistic regression, tree-based classifiers, k-nearest neighbor classifier, support vector classifier or support vector machine.

Claim 10 is second of the two independent claims in this application. Claim 10 relates to a method for a carrier to initiate payment of a bill by a bill recipient to a creditor. The method comprising the following steps:

(a) scanning the PIUE (Fig. 6 600, Paragraph 0053, Page 18) to generate scanned image data, the scanned image data comprising pixel data, the pixel data comprising gray scale values and representing the PIUE as a set of scanning pixels;

(b) forming a plurality of data blocks (Fig. 6 602, Paragraph 0054, Page 18) from the scanned image data, each data block consisting of pixel data which corresponds to a respective region of the PIUE;

(c) transforming the pixel data (Fig. 6 606, Paragraph 0056, Page 18) in at least some of the data blocks to obtain transform domain data by applying at least one of a Fourier

transform, a fast Fourier transform, a discrete cosine transform (DCT) and a wavelet transform to the pixel data in the at least some of the data blocks to obtain the transform domain data;

(d) applying a watermark (Fig. 6 608, Paragraph 0056, Page 18) detecting operation to the transform domain data for respective ones of the data blocks to generate recovered watermark data; and

(e) determining at least one of (i) a correlation (Fig. 6612, Paragraph 0058 Page 19) between the recovered watermark data for at least some of the data blocks and average

The potion of Appellant's specification that describes claim 10 has been set forth above.

VI. Grounds of Rejection to be Reviewed on Appeal

A. Whether or not claims1 and 10 are patentable under 35 use §112 for failing to comply with the written description.

B. Whether or not claims 1-2,4, 9-13, and 14-15 are patentable under 35 use §1 02(e) over Sharma et al. (US Publication No. 2004/0105569).

C. Whether or not claims 6-7 and 16-17,are patentable under 35 use §103(a) over Sharma in view of Murakami (US Patent No. 7,065,237).

D. Whether or not claims 8 and 18 are patentable under 35 use §1 03(a) over Sharma in view of Rhoads et al. (US Publication No. 2003/0215112).

VII. Argument

A. Claims 1and 10 have been rejected by the Examiner under 35 use §112 for failing to comply with the written description.

The Examiner indicated in page 3 of the Final Rejection that there is no support in paragraph [0057] of Appellant's specification for the expression "average brightness levels for said data blocks" in step (e) of claims 1 and 10.

Appellant respectfully disagrees with the Examiners opinion. There is support in paragraph [0057] for the expression "average brightness levels for said data blocks" in step (e) of claims 1 and 10. Paragraph 057 of Appellant's specification reads as follows.

> "[0057] At step 610 (which may precede or follow steps 606, 608) the brightness of the data block in question may be determined. This may be done, for example, by calculating an average gray scale value of the pixels in the data block."

The reason for the foregoing is that for each data block, there is only one brightness level, therefore, the average brightness level is the same as the brightness level

because it has the same numeric value. The term "average" is included in claims 1 and 10 to clarify that the brightness level for each data block is an average of pixel gray scale values. When a correlation is performed in step (e) of claims 1 and 10, the detection of the watermark data is independent of the brightness level. The watermarked signal strength (recovered watermarked data) of Appellant's claimed invention is correlated with the brightness level.

B. Claims 1-2, 4, 9-13, and 14-15 have been rejected by the Examiner under under 35 USC §102(e) over Sharma et al. (US Publication No. 2004/0105569).

Sharma discloses the following in paragraph [0093]:

> "[0093] Next, the detector performs a correlation 610 between the transformed image block and the transformed orientation pattern 612. At a high level, the correlation process slides the orientation pattern over the transformed image (in a selected transform domain, such as a spatial frequency domain) and measures the correlation at an array of discrete positions. Each such position has a corresponding scale and rotation parameter associated with it. Ideally, there is a position that clearly has the highest correlation relative to all of the others. In practice, there may be several candidates with a promising measure of correlation. As explained further below, these candidates may be subjected to one or more additional correlation stages to select the one that provides the best match."

Sharma is looking for correlation between a pattern and an image at the same frequency.

Sharma discloses the following in paragraph [0201]:

> "[0201] There are a number of ways to calculate this figure of merit. One figure of merit is the degree of correlation between a known watermark signal attribute and a corresponding attribute in the signal suspected of having a watermark. Another figure of merit is the strength of the watermark signal (or one of its components) in the suspect signal. For example, a figure of merit may be based on a measure of the watermark message signal strength and/or origination pattern signal strength in the signal, or in a part of the signal from which the detector extracts the orientation parameters. The detector may computes a figure of merit based the strength of the watermark signal in a sample block. It may also compute a figure of merit based on the percentage agreement between the known bits of the message and the message bits extracted from the sample block."

Sharma discloses obtaining a signal level in a block, not how it relates to brightness in a block.

Sharma discloses the following in paragraphs [0186], [0188] and [0190]:

"[0186] 4.3 Estimating Translation Parameters.

[0188 In this stage, the detector estimates translation parameters. These parameters indicate the starting point of a watermarked block in the spatial domain. The translation parameters, along with rotation, scale and differential scale, form a complete 60 orientation vector. The 60 vector enables the reader to extract luminance sample data in approximately the same orientation as in the original water-marked image.

[0190] To extract translation parameters, the detector proceeds as follows. In the multi-frame case, the detector selects the frame that produced 40 orientation vectors with the highest detection values (1080). It then processes the blocks 1082 in that frame in the order of their detection value. For each block (1084), it applies the 4D vector to the luminance data to generate rectified block data (1086). The detector then performs dual axis filtering (1088) and the window function (1090) on the data. Next, it performs an FFT (1092) on the image data to generate an array of Fourier data. To make correlation operations more efficient, the detector buffers the Fourier values at the orientation points (1094)."

The function described in Sharma paragraph [0188] describes Sharma's paragraph [0186] Estimating Translation Parameters. The purpose in Sharma paragraph [0188] is to estimate the rotation, scale, and differential scale of the 60 orientation vector. This estimate depends on the variation of the pixel gray scale values, but not on the (average pixel gray scale value) average brightness level. The average value will provide no information with regards to translation, scale and orientation. IN Applicant's claimed invention the strength of the varying watermark signal is dependent on the average pixel gray scale value in copies.

In paragraph [0190] Sharma discloses finding the orientation vector that maximizes the detection values. Applicant claims analyzing the strength of the watermark signal as a function of the wave vector of the watermark signal. This dependence will change upon copying.

The following will provide a simplified one dimensional illustration of the concepts in Sharma and in the claims of this application. The "Orientation Vector" in one dimension is just the phase (position) and wavelength rather than the four or six dimensional vector used in Sharma. The one dimensional example is sufficient to illustrate the point.

First set up indices for the pictures:

$r := 0..100 \qquad c := 0..50$

Next, as an example, we create a simple image with two data blocks that are uniform

$\text{Light} := 225 \qquad \text{Dark} := 100 \qquad \text{Orig}_{r,c} := \text{Dark} + (\text{Light} - \text{Dark}) \cdot \Phi(r - 50.1)$

Now we add a watermark to the image. For simplicity we illustrate with a simple sinusoidal watermark.

$\text{WM}_{r,c} := \text{Orig}_{r,c} + 10 \cdot \cos(c)$

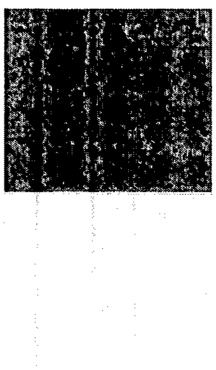
In the signal in Sharma the geometry is distorted. Here we illustrate an example where the phase is shifted and the length scaled. In the general case in Sharma there is a four or six dimenaional orientation vector.

$\text{Media}_{r,c} := 100 + 125 \cdot \Phi(r - 50.1) + (7 + 3 \cdot \Phi(50.1 - r)) \cdot \cos(c \cdot 1.1 + 2.3)$

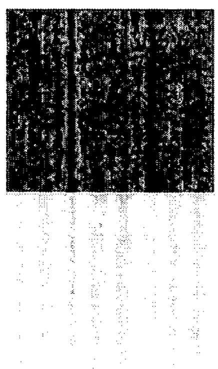
If someone tries to copy a printed image the watermark strength will change differently in data blocks that are lower brightness than in data blocks that are higher brightness.

$\text{Copy}_{r,c} := 100 + 125 \cdot \Phi(r - 50.1) + (5 + 5 \cdot \Phi(50.1 - r)) \cdot \cos(c \cdot 1.1 + 2.3)$

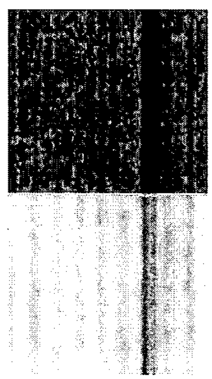
An original image, a watermarked digital image, a transformation of the original image to media such as printing and a copy made from the media are illustrated schematically:



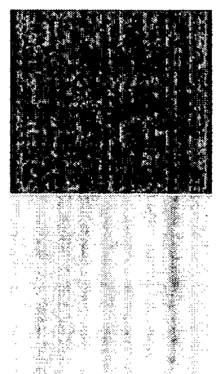
Orig



WM



Media



Copy

Sharma searches for the orientation vector that provides the strongest signal using a watermark detector. Here we use a Fourier transform as the detector:

Define the expected range of wavevectors for the watermark $c_{min} := 2$ $\quad c_{max} := 12$

$c_1 := c_{min} .. c_{max}$ $\quad C_{test}(x, y) := (x \geq c_{min}) \wedge (x \leq c_{max})$ $\quad \underset{\sim}{C} := \text{matrix}(51, 1, C_{test})$

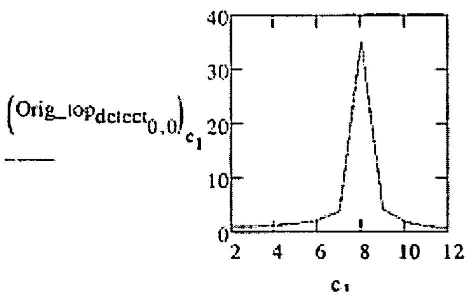
$$\text{Detect}(f) := \left[\overrightarrow{(|\text{cfft}(f)| \cdot C)} \;\; \arg(\text{cfft}(f)) \right]$$

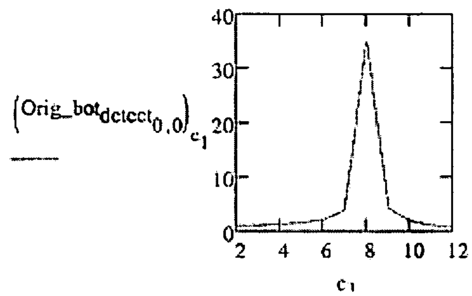
$$\text{Orig\_top}_{detect} := \text{Detect}\left[\left(WM^T \right)^{\langle 25 \rangle} \right] \qquad \text{Orig\_bot}_{detect} := \text{Detect}\left[\left(WM^T \right)^{\langle 75 \rangle} \right]$$

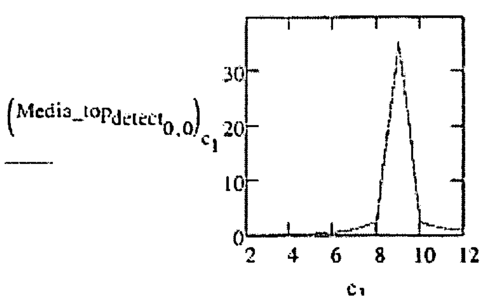
$$\text{Media\_top}_{detect} := \text{Detect}\left[\left(\text{Media}^T \right)^{\langle 25 \rangle} \right] \qquad \text{Media\_bot}_{detect} := \text{Detect}\left[\left(\text{Media}^T \right)^{\langle 75 \rangle} \right]$$

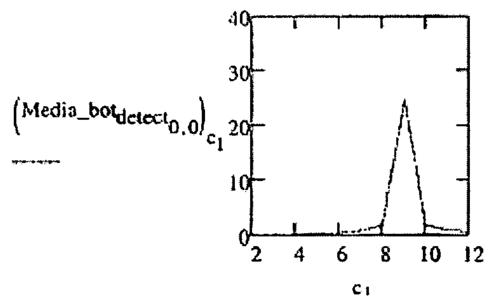
$$\text{Copy\_top}_{detect} := \text{Detect}\left[\left(\text{Copy}^T \right)^{\langle 25 \rangle} \right] \qquad \text{Copy\_bot}_{detect} := \text{Detect}\left[\left(\text{Copy}^T \right)^{\langle 75 \rangle} \right]$$

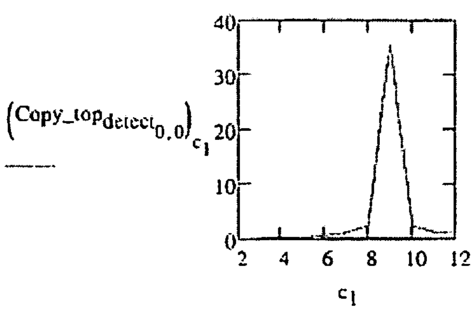
Now Sharma scans the expected range of orientation vectors (in this case phase and wavevector) to find the watermark peak.

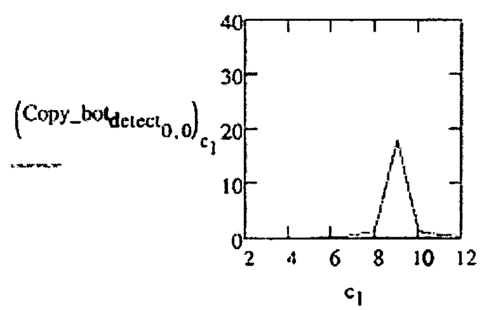












Note that the location of the peak shifted from a wavevector of 8 in the original to a wavevector of 9 in the media signal and in the copy gives the scale of the watermark. The phase of the peak signal gives the location information for the watermark. The phase is the same in the top and bottom of the image.

$\left(\text{Orig\_top}_{\text{detect}_{0,1}}\right)_8 = -0.362$ $\qquad$ $\left(\text{Media\_top}_{\text{detect}_{0,1}}\right)_8 = 1.13$

$\left(\text{Orig\_bot}_{\text{detect}_{0,1}}\right)_8 = -0.362$ $\qquad$ $\left(\text{Media\_bot}_{\text{detect}_{0,1}}\right)_8 = 1.13$

Notice that in the media signal above, the amplitude of the signal in the bottom brighter region is lower than in the top region. On the other hand, the phase is the same in the top and bottom. Sharma teaches using the phase and peak wavelength to determine the orientation vector. Although the signal strength is lower in the detected Media_bot watermark, this has no influence on the orientation vector. Thus the orientation vector in Sharma is independent of brightness in the data region.

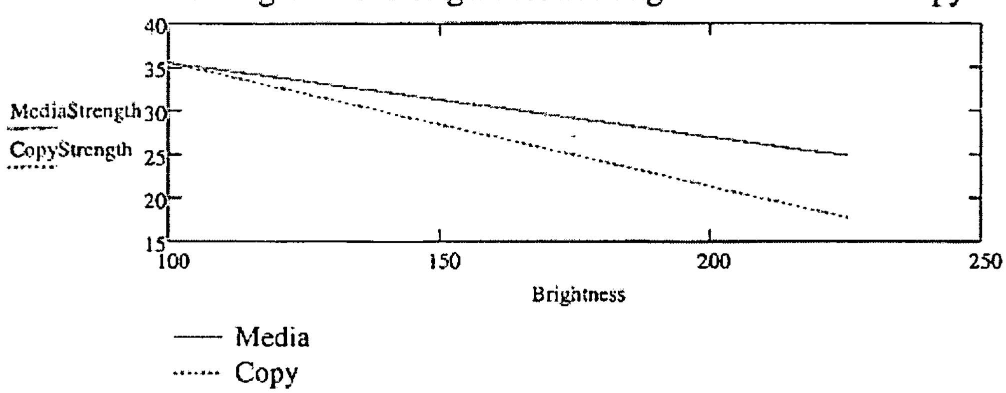
In our case, the strength of the watermark in the copy depends on the brightness in the data block. The following illustrates an image with only two data blocks with a simple sinusoidal watermark.

$\text{Brightness} := \begin{pmatrix} \text{Dark} \\ \text{Light} \end{pmatrix}$ The brightness for the two data regions

$\text{MediaStrength} := \begin{pmatrix} \max\left(\text{Media\_top}_{\text{detect}_{0,0}}\right) \\ \max\left(\text{Media\_bot}_{\text{detect}_{0,0}}\right) \end{pmatrix}$ Expected signal strength of an original watermarked medium

$\text{CopyStrength} := \begin{pmatrix} \max\left(\text{Copy\_top}_{\text{detect}_{0,0}}\right) \\ \max\left(\text{Copy\_bot}_{\text{detect}_{0,0}}\right) \end{pmatrix}$ Signal strength of a copied medium

Strength versus brightness for original media and a copy



Sharma discloses step (d) of claim 1, namely, applying a watermark detecting operation to the transform domain data for respective ones of the data blocks to generate recovered

watermark data.

However, Sharma does not disclose or anticipate step e. of Claim 1, namely, determining a correlation between the recovered watermark data for at least some of the data blocks and average brightness levels for said data blocks.

Sharma discloses step (d) of claim 1, namely, applying a watermark detecting operation to the transform domain data for respective ones of the data blocks to generate recovered watermark data.

However, Sharma does not disclose or anticipate step e. of Claim 10, namely, determining at least one of (i) a correlation between the recovered watermark data for at least some of the data blocks and average brightness levels for said data blocks, and (ii) a correlation between the recovered watermark data and the wave vectors.

An advantage of step e. of Claims 1 and 10, over Sharma is that if someone made a copy, the copy process would weaken the watermark more in light areas than in dark areas. The foregoing will make a fraudulent copy easier to detect.

C. Claims 6-7 and 16-17, have been rejected by the Examiner under 35 use §103(a) over Sharma in view of Murakami (US Patent No. 7,065,237).

Claim 6 depends on claim 4 which depends on claim 1. Claim 7 depends on claim 6. Claim 16 depends on claim 14 which depends on claim 10. Claim 17 depends on claim 16, which depends on claim 14.

In addition to the arguments made in above Section S, please consider the following.

Murakami discloses the following in col. 9, lines 10-26:

> "The envelope ring pattern generator 902 is a device for generating an envelope ring pattern on the basis of the input additional information and a Fourier amplitude spectrum generated by the Fourier transformer 901. The envelope ring pattern generator 902 is further connected to the envelope ring pattern embedding unit 903.
>
> The envelope ring pattern embedding unit 903 is a device for embedding an envelope ring pattern in a Fourier amplitude spectrum on the basis of the Fourier amplitude spectrum generated by the Fourier transformer 901, the envelope ring pattern generated by the envelope ring pattern generator 902, and the parameter which is input from the parameter input unit 906 and changes depending on the watermark strength or for each embedding. The envelope ring pattern embedding unit 903 is further connected to the inverse Fourier transformer 904."

Muakami discloses embedding an envelope ring pattern in a Fourier amplitude spectrum.

Sharma and Murakami, taken separately or together, do not disclose or anticipate step e. of claims 1 and 10.

Notwithstanding the foregoing, in rejecting a claim under 35 U.S.C. §103, the Examiner is charged with the initial burden for providing a factual basis to support the obviousness conclusion. *In re Warner,* 379 F.2d 1011, 154 USPQ 173 (CCPA 1967); *in re Lunsford,* 375 F.2d 385, 148 USPQ 721 (CCPA 1966); *in re Freed,* 425 F.2d 785, 165 USPQ 570 (CCPA 1970). The Examiner is also required to explain how and why one having ordinary skill in the art would have been led to modify an applied reference and/or combine applied references to arrive at the claimed invention. *In re Ochiai,* 37 USPQ2d 1127 (Fed. Cir. 1995); in re Deuel, 51 *F.3d* 1552, 34 *USPQ 1210 (Fed. Gir.* 1995); *in re Fritch,* 972 F.2d 1260, 23 USPQ 1780 (Fed. Cir. 1992); *Uniroyal, Inc. v. Rudkin-Wiley Corp.,* 837 F.2d 1044,5 USPQ2d 1434 (Fed. Cir. 1988). In establishing the requisite motivation, it has been consistently held that both the suqqestion and reasonable expectation of success must stem from the prior art itself, as a whole. *In re Ochiai,* supra; in re Vaeck, 947 *F.2d* 488, *20 USPQ2d* 1438 *(Fed. Gir.* 1991); *in re Fine,* 837 F.2d 1071,5 USPQ2d 1596 (Fed. Cir. 1988); *in re Dow Chemical* Co., 837 F.2d 469,5 USPQ2d 1529 (Fed. Cir. 1988).

D. Claims 8 and 18 have been rejected by the Examiner under 35 USC §103(a) over Sharma in view of Rhoads et al. (US Publication No. 2003/0215112).

Claim 6 depends on claim 1. Claim 18 depends on claim 10.

In addition to the arguments made in above Sections Band C, please consider the following.

Rhoads discloses the following in paragraph [0118]:

> "[0118] The uses to which the 128 bits of watermark data can be put in security documents are myriad. Many are detailed in the materials cited above. Examples include postal stamps encoded with their value, or with the zip code of the destination to which they are addressed (or from which they were sent); banknotes encoded with their denomination, and their date and place of issuance; identification documents encoded with authentication information by which a person's identity can be verified, etc., etc.,"

Rhoads discloses a printed image that is a postal indicia.

However, Sharma and Rhoads, taken separately or together, do not disclose or anticipate step e. of Claims 1 and 10, as amended.

Prayer for Relief

Appellant's respectfully submit that appealed claims 1,2,4 -12 and 14 - 19 in this application are patentable. It is requested that the Board of Appeal overrule the Examiner and direct allowance of the rejected claims

Respectfully submitted,

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VIII. Appendix of Claims Involved in the Appeal

1. A method of determining whether a printed-image-under examination (PIUE) is a copy of an original printed image, the method comprising:

(a) scanning the PIUE to generate scanned image data, the scanned image data comprising pixel data, the pixel data comprising gray scale values and representing the PIUE as a set of scanning pixels;

(b) forming a plurality of data blocks from the scanned image data, each data block consisting of pixel data which corresponds to a respective region of the PIUE;

(c) transforming the pixel data in at least some of the data blocks to obtain transform domain data by applying at least one of a Fourier transform, a fast Fourier transform, a discrete cosine transform (DCT) and a wavelet transform to the pixel data in the at least some of the data blocks to obtain the transform domain data;

(d) applying a watermark detecting operation to the transform domain data for respective ones of the data blocks to generate recovered watermark data; and

(e) determining a correlation between the recovered watermark data for at least some of the data blocks and average brightness levels for said data blocks.

2. The method according to claim 1, further comprising:

(f) determining that the PIUE is a copy of the original printed image if a strength of a brightness level of the recovered watermark data is negatively correlated with the brightness levels for said data blocks.

4. The method according to claim 1, wherein the watermark detecting operation includes multiplying the transform domain data with a detecting function.

5. The method according to claim 4, wherein the detecting function is eikr, where k and r are phase space indices applicable to the transform domain data.

6. The method according to claim 4, wherein the detecting operation further includes applying an envelope function to the transform domain data that has been multiplied by the detecting function.

7. The method according to claim 6, wherein the detecting operation further includes applying an inverse transform to the transform domain data that has been multiplied by the detecting function and to which the envelope function has been applied.

8. The method according to claim 1, wherein the PIUE is part of a postal indicium.

9. The method according to claim 1, wherein at least one of the regions of the PIUE overlap with one or more other regions of the PIUE to which the data blocks correspond are overlapping with each other.

10. A method of determining whether a printed-image-under examination (PIUE) is a copy of an original printed image, the original printed image including a watermark applied to the image using a plurality of wave vectors, the method comprising:

(a) scanning the PIUE to generate scanned image data, the scanned image data comprising pixel data, the pixel data comprising gray scale values and representing the PIUE as a set of scanning pixels;

(b) forming a plurality of data blocks from the scanned image data, each data block consisting of pixel data which corresponds to a respective region of the PIUE;

(c) transforming the pixel data in at least some of the data blocks to obtain transform domain data by applying at least one of a Fourier transform, a fast Fourier transform, a discrete cosine transform (DCT) and a wavelet transform to the pixel data in the at least some of the data blocks to obtain the transform domain data;

(d) applying a watermark detecting operation to the transform domain data for respective ones of the data blocks to generate recovered watermark data; and

(e) determining at least one of (i)a correlation between the recovered watermark data for at least some of the data blocks and average brightness levels for said data blocks, and (ii) a correlation between the recovered watermark data and the wave vectors.

11. The method according to claim 10, further comprising:

(f) determining that the PIUE is a copy of the original printed image if a signal level of the recovered watermark data decreases with the brightness levels for said data blocks.

12. The method according to claim 10, further comprising:
(f) determining that the PIUE is a copy of the original printed image if a signal level of the recovered watermark data increases with wavelengths of the wave vectors.

14. The method according to claim 10, wherein the watermark detecting operation includes multiplying the transform domain data with a detecting function.

15. The method according to claim 14, wherein the detecting function is eikr, where k and r are phase space indices applicable to the transform domain data.

16. The method according to claim 14, wherein the detecting operation further includes applying an envelope function to the transform domain data that has been multiplied by the detecting function.

17. The method according to claim 16, wherein the detecting operation further includes applying an inverse transform to the transform domain data that has been multiplied by the detecting function and to which the envelope function has been applied.

18. The method according to claim 10, wherein the PIUE is part of a postal indicium.

19. The method according to claim 10, wherein at least one of the regions of the PIUE overlap with one or more other regions of the PIUE to which the data blocks correspond are overlapping with each other.

IX. EVIDENCE APPENDIX

There is no additional evidence to submit.

XI RELATED PROCEEDING APPENDIX

There are no related Appeals and Interferences.